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Mena Lafkioui
Università di Milano-Bicocca – Ghent University

DIALECTOMETRY ANALYSES OF BERBER LEXIS[1]

1. Introduction to methods in dialectometry

Dialectometry is a quantitative methodology for calculating linguistic distances between linguistic varieties. The most frequently used dialectometry methods can be divided into the categories of traditional and computational methods.[2]

The most well-known traditional approaches are those based on the concept of isogloss, which is a line that bisects a geographic map into separate zones according to the detected linguistic features. The classification of the varieties is deducted from the arrangement of isoglosses, clusters of isoglosses (Goossens 1969) or clusters of demarcative isoglosses (Stankiewicz 1957; Garde 1961) on the geolinguistic map.[3] Although this method allows for verification of the visualised facts, it has several disadvantages, including the difficulty to

[1] This article reflects, in large part, the content of Lafkioui (forthcoming 2). This publicaion is made possible by a Postdoctoral Fellowship grant from the Flemish Fund for Scientific Research (FWO).

[2] There also exist different *perceptual approaches* that permit to draw sociolinguistic borders based on the speaker's "dialectal conscience" (Weijnen 1946, 1966; Rensink 1955; Daan, Blok 1969; Gooskens 1997, 2002; among others).

[3] The qualifying term "demarcative", added to the common dialectology criterion of "isogloss clusters" (Goossens: 1969: 54), refers to the structural value of the isoglosses relating to the material aspect of the phenomena as well as to their relative distribution (direction and density). Thus, not only the quantitative dimension (number) of isoglosses is relevant to the typology of classification, but also the qualitative aspect, i.e. their degree of importance. However, non-demarcative isoglosses may also be of great significance for the classification, especially when they allow an evaluation of the results. On the relationship between "structuralism" and "dialectology", see Forquet (1956), Weinreich (1954), Grosse (1960) and Martinet (1972), among others.

find clusters of isoglosses that precisely divide the geolinguistic area examined (Kessler 1995; Chambers, Trudgill 1998).[4]

Another traditional technique is the geolinguistic structuring method which divides a geographic area depending on the linguistic structure of its varieties (Moulton 1960; Goossens 1965; among others). For instance, varieties with the same phonemic system are part of the same geolinguistic group. However, classifications based on this method are mainly phonological and therefore lack an interpretation basis that is connected to other linguistic dimensions.[5]

The computational dialectometry methods are numerous and are currently considered most adequate for reasons I will explain later on in this article. The foundations of digital automated dialectometry were established by Séguy (1973) with his analytical method to calculate the linguistic differences between varieties of Gascogne. The comparison is based on an algorithm which classifies data as identical or non-identical. The sum of the measured distances between two varieties matches their linguistic distance. The visualisation of the classification analysis is conducted through lines of various types (bold/non bold, dotted/non dotted, etc.), which divide the region according to the linguistic differences of the varieties. As a counterpart, Goeble (1982, 1993) has calculated the similarities between varieties from Italy and Southern Switzerland. Even though the results of the calculation of Séguy and Goeble have the merit of being objective, they lack refinement because their technique excludes distance graduation.

The main computational methods based on the frequency of linguistic variants are the "Corpus Frequency Method" (Hoppenbrouwers, Hoppenbrouwers 1988, 2001) and the "Frequency per Word Method" (Nerbonne, Heeringa 1998, 2001). The basic principle of the first approach is that the degree of difference/similarity between two varieties is derived from comparing the frequency of the marked linguistic features of their variants. The problem in this approach is that the entity "word" is not considered as a linguistic unit. However, this obstacle is removed by the second approach which assigns to words the status of "units" functioning as such. Nevertheless, the two classification tools do not take into account the order of the phonic units in the sequence.

The "Levenshtein distance" (Lv), on the other hand, allows incorporating the parameter of sequential ordering of phonic units in the classification, which makes it more appropriate than other digital/numerical methods. This tool

[4] A significant critique on this method is that it cannot completely exclude some subjectivity because isoglosses might be chosen, *a priori*, according to the linguistic borders they yield (Goossens 1977).

[5] Although the frequency of the compared variants is taken into account (Kocks 1970), this approach does not seem to be the most appropriate (Heeringa 2004: 24-25).

has been introduced in dialectometry by Kessler (1995), who has applied it to a corpus of Irish Gaelic. The Levenshtein distance measure corresponds to the numerical value of the lowest cost of operations (insertions, deletions and substitutions) needed to convert a string of characters into another (Kruskal 1999). One of the most employed techniques of comparison is the "phone string comparison" in which all operations have the same cost, regardless of the degree of affinity between the phonic units: the pair [t, d] has the same cost as the pair [u, t] and [u, u:]. Yet, with the technique of "feature string comparison" phonetic features of phonic units can be compared: the cost of the pairs [u, t] and [u, u:] is not equal because the phonetic affinity between the phonic units of [u, u:] is greater than that of [u, t].

2. Dialectometry analyses of Berber lexis

Among the different existing dialectometry approaches, I prefer the computational methods because they allow handling large data corpora with certain ease, while ensuring the accuracy and consistency of the analyses. These aims can be achieved thanks to the fact that

- Distances and frequencies are measured automatically.
- Data are classified digitally.
- Mapping can be assisted by the computer.
- Statistical analyses can be made and displayed automatically.

The dialectometry analyses that I present in this article were performed with the free software of Kleiweg (RuG/L04).[6] In order to complete a displayed dialectometry analysis, all the procedural steps summarised below are indispensable (Lafkioui forthcoming 1):

Table 1: General procedure of computational dialectometry analysis

Step 1	Linguistic Atlas = georeferenced data source
Step 2	Data Matrix
Step 3	Distance Matrix
Step 4	Analysis
Step 5	Visualisation

[6] Http://odur.let.rug.nl/~kleiweg/L04.

2.1. The Linguistic Atlas of the Rif as a data source

The Rif is that region of North Morocco stretching from the Strait of Gibraltar in the West to the Algerian frontier in the East. The Rif-Berber varieties (Tarifit) belong to the northern Berber languages and thus are part of the large Afro-Asiatic language phylum. The Berber-speaking area of the Rif is delimited:

- In the West, by the varieties of the Ktama tribe, (the so-called Senhaja varieties).

- In the South, by the koinè of Gersif, which is the ultimate geographic point where Rif-Berber (Tarifit) is spoken before reaching the corridor of Taza.

- In the East, by the varieties of Iznasen, which have spread to the regions of Arabic speaking varieties to the Morocco-Algerian border.

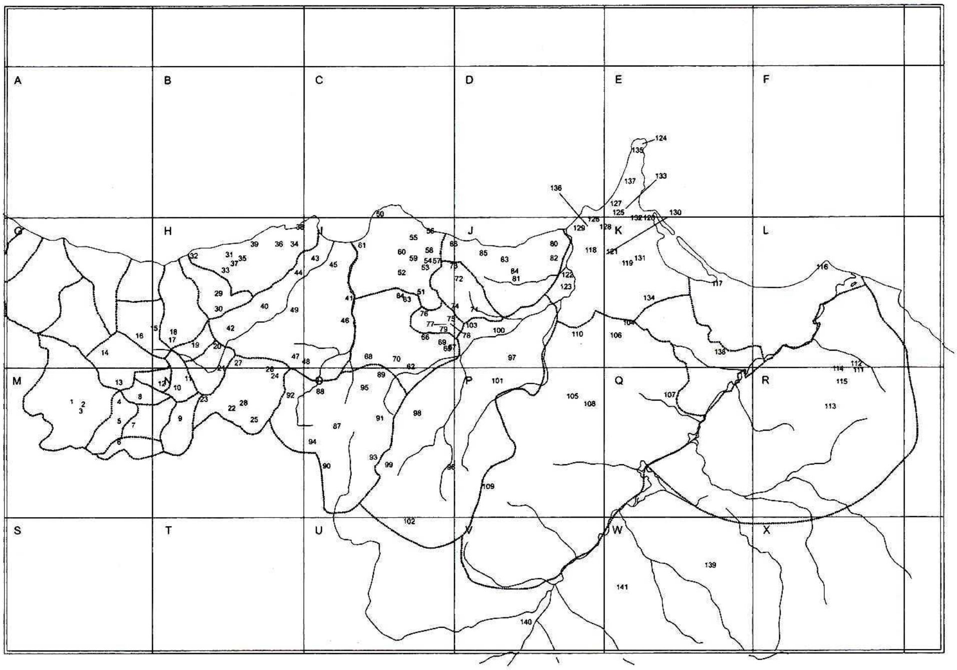
The lexical data which are compared and classified in this study are collected from the *Atlas linguistique des variétés berbères du Rif* (Lafkioui 2007) or ALR. The digital data corpus consists of sixty-two lexemes regarding the human body (maps 295 to 315), kinship (maps 316 to 321 cards), animals (maps 322 to 327), colours (maps 328 and 329), numbers (maps 330 to 332), besides a subset of various nouns and verbs (maps 333 to 356). Of these lexemes, eleven have only one variant per variety; all fifty-one other lexemes display the co-occurrence of multiple variants for each lexeme.

Due to the completion of the automated ALR, the data obtained from it are already in digital format, which has avoided a great task of digitising. However, an adaptive conversion to the software RuG/L04 (Kleiweg) was necessary. The ALR also offers a precise digital map of the Rif region (see Figure 1), which is essential to the visualisation of the dialectometry analyses, except for the dendrogram.

One hundred forty-one georeferenced points – belonging to thirty-two Rif tribes – were selected from a group of four hundred fifty-two localities in the Rif according to their degree of linguistic variation (Lafkioui 2007).[7]

[7] The survey points were selected on the basis of the principle of equidistance dividing the inquiry field into several grids to which were assigned points that could match with localities on the field. The greater the variation was, the more the grids were reduced. The four hundred fifty-two locations selected for this research were for the most part chosen so that they could, a priori, indicate linguistic borders. This selection mainly stemmed from the scientific and empirical knowledge of the investigator on the different varieties spoken in the Rif area.

Figure 1: Map of the georeferenced survey points of the Rif (Lafkioui 2007)



2.2. Data matrix of Rif-Berber lexis

The data matrix is composed of digital lexical excerpts from the ALR (Lafkioui 2007) converted following the format of the software RuG/L04 (Kleiweg). Here below, a small sample in digital format of the ALR (Mapinfo Professional format; Table 2) and in text format of RuG/L04 (Table 3) are given:

Table 2: Data excerpt in digital format of ALR

SECTOI	TRIBE	FULL_NAME_NB	LF461	LF462	LF463	LF464	LF465	LF466	LF467	LF468	LF469	LF470
1	Ktama	Asammer	31	51	52	32	54	51	32	33	53	52
1	Ktama	Lmexzen	31	51	52	32	54	51	32	33	53	52
1	Ktama	Ssahel	31	51	52	32	54	51	32	33	53	52
2	Taghzut	Lqel'a	31	54	52	32	54	51	34	33	54	52
2	Taghzut	Ssaqya	31	54	52	32	54	51	34	33	54	52
3	Ayt Bucibet	Tarya	31	54	52	32	54	51	32	33	54	52
4	Ayt Hmed	Mazuz	31	51	52	32	54	51	32	33	54	52
5	Ayt Bunsar	Luta	31	32	52	32	54	51	32	33	51	52
6	Ayt Bcir	Tizirt	31	51	52	32	52	51	33	31	51	52
7	Zerqet	Aghennuy	31	32	52	32	52	51	33	31	51	52
7	Zerqet	Wersan	31	32	52	32	52	51	33	31	51	52
8	Ayt Xennus	A'raben	31	32	52	32	54	51	32	33	53	52
9	Ayt Seddat	Azila	31	32	52	32	54	51	32	33	53	52
9	Ayt Seddat	Tamadda	31	32	52	32	54	51	32	33	53	52
A	Ayt Gmil	Azru n tili	53	53	53	32	51	54	31	52	53	53
A	Ayt Gmil	Tizi	53	53	53	32	51	54	31	52	53	53
B	Ayt Bufrah	Igzennayen	53	32	52	32	51	13	31	52	53	52
B	Ayt Bufrah	Iharunen	53	32	52	32	51	13	31	52	53	52
C	Targist	Ayt 'Azza	54	52	53	53	51	12	53	52	53	53
D	Ayt Mezduy	Bni Budjay	53	53	53	32	51	54	31	52	53	53
D	Ayt Mezduy	Bu'di	53	32	52	32	51	51	31	52	53	52

Table 3: Data excerpt in text format of RuG/L04

: Asammer
- aqnin
: Lmexzen
- aqnin
: Ssahel
- aqnin
: Lqel'a
- aqnin
: Ssaqya
- aqnin
: Tarya
- aqnin
: Mazuz
- aqnin
: Luta
- aqnin
: Tizirt
- aqnin
: Aghennuy
- aqnin
: Wersan
- aqnin
: A'raben
- aqnin
: Azila
- aqnin
: Tamadda
- aqnin
: Azru n tili
- aqenni
: Tizi
- aqenni
: Igzennayen
- aqenni
: Iharunen
- aqenni
: Ayt 'Azza
- aqnenniy
: Bni Budjay
- aqenni
: Bu'di
- aqenni
: Aghir Hmed
- aqenni
: Asammar
- aqenni
: Ayt Hmed
- aqenni
: Sidi Bucetta
- aqenni
: Tazrut
- aqenni
: Ufis
- aqenni
: Wad Mahkim
- aqenni
: L'ars
- aqenni
: Tufist-Imuruten
- aqenni

2.3. Distance matrix of Rif-Berber lexis

This section contrasts the three most employed digital comparison techniques: the Binary distance (Hamming algorithm), the Gewichteter Identitätswert distance (Weighted identity value), and the Levenshtein distance. I will apply these techniques on the Rif-Berber lexical corpus to test their validity and to select the most appropriate to Berber. Each distance measuring allows acquiring precise numerical values derived from the linguistic comparison between the varieties of the Rif area. These values make up the distance matrices (symmetric matrices N × N, N= sum of varieties), whose configuration differs depending on the adopted algorithm.

2.3.1. Binary distance

The Binary distance (Bin) is used to classify lexical units as being identical or non-identical: comparison of type 0-1; 0= resemblance and 1= difference. Table 4 presents an excerpt from the Binary distance matrix of the lexeme "heel" (ALR, map 312):

Table 4: Excerpt from the Binary distance matrix of the lexeme "heel"

	Tizirt	Aghennuy	Wersan	A'raben	Azila	Tamadda	Azru n tili	Tizi
Wersan	0	0	0	0	0	0	1	1
A'raben	0	0	0	0	0	0	1	1
Azila	0	0	0	0	0	0	1	1
Tamadda	0	0	0	0	0	0	1	1
Azru n tili	1	1	1	1	1	1	0	0
Tizi	1	1	1	1	1	1	0	0
Igzennayen	1	1	1	1	1	1	0	0
Iharunen	1	1	1	1	1	1	0	0
Ayt 'Azza	1	1	1	1	1	1	1	1

2.3.2. Gewichteter Identitätswert distance

The Gewichteter Identitätswert distance (GIW) deviates from the Binary distance in that the frequency of the lexical variants is considered in the comparison: low-frequency variants weigh heavier than high-frequency variants. The distance obtained by this technique varies between 0 and 1; $\{0 \leq d \leq 1\}$. Table 5 presents an extract from the distance matrix of the lexeme "heel":

Table 5: Excerpt from the GIW distance matrix of the lexeme "heel"

	Tizirt	Aghennuy	Wersan	A'raben	Azila	Tamadda	Azru n tili	Tizi
Wersan	0.0501792	0.0501792	0	0.0501792	0.0501792	0.0501792	1	1
A'raben	0.0501792	0.0501792	0.0501792	0	0.0501792	0.0501792	1	1
Azila	0.0501792	0.0501792	0.0501792	0.0501792	0	0.0501792	1	1
Tamadda	0.0501792	0.0501792	0.0501792	0.0501792	0.0501792	0	1	1
Azru n tili	1	1	1	1	1	1	0	0.215054
Tizi	1	1	1	1	1	1	0.215054	0
Igzennayen	1	1	1	1	1	1	0.215054	0.215054
Iharunen	1	1	1	1	1	1	0.215054	0.215054
Ayt 'Azza	1	1	1	1	1	1	1	1

2.3.3. Levenshtein distance

The distance values resulting from a Levenshtein-based comparison – an algorithm taking into account the sequential order of phonic units composing lexemes – fluctuate between 0 and 1, $\{0 \leq d \leq 1\}$, as shown in the following excerpt:

Table 6: Excerpt from the Lv distance matrix of the lexeme "heel"

	Tizirt	Aghennuy	Wersan	A'raben	Azila	Tamadda	Azru n tili	Tizi
Wersan	0	0	0	0	0	0	0.6	0.6
A'raben	0	0	0	0	0	0	0.6	0.6
Azila	0	0	0	0	0	0	0.6	0.6
Tamadda	0	0	0	0	0	0	0.6	0.6
Azru n tili	0.6	0.6	0.6	0.6	0.6	0.6	0	0
Tizi	0.6	0.6	0.6	0.6	0.6	0.6	0	0
Igzennayen	0.6	0.6	0.6	0.6	0.6	0.6	0	0
Iharunen	0.6	0.6	0.6	0.6	0.6	0.6	0	0
Ayt 'Azza	0.555556	0.555556	0.555556	0.555556	0.555556	0.555556	0.111111	0.111111

These values result from the selection of the least costly calculation to transform a lexical unit – as a string of phonic units – into another. Table 7 depicts the lowest cost of operations which allow modifying the string *awrez* (heel) into *inerz* (heel):

Table 7: Cost of operations allowing modification of *awrez* into *inerz* (heel)

		a	w	r	e	z
	0	0.5	1	1.5	2	2.5
i	0.5	1	1.5	2	2.5	3
n	1	1.5	2	2.5	3	3.5
e	1.5	2	2.5	3	2.5	3
r	2	2.5	3	2.5	3	3.5
z	2.5	3	3.5	3	3.5	3

The lowest cost of operations amending *awrez* into *inerz* is 3, which implies that the distance between these two lexemes is 3/5 (5 being the total number of features); consequently, the Levenshtein distance is 60%. These calculations are based on operations that cost 0.5 for an insertion or deletion and 1 for a substitution. Table 8 illustrates this calculation technique:

Table 8 : Example of calculation of Lv distance for modifying *awrez* into *inerz* (heel)

Tamadda	a	w	r	e		z	
Tizi	i	n		e	r	z	
Lv Distance	1	1	0,5	0	0,5	0	**3/5 * 100 = 60%**

2.4. Numerical dialectometry analyses of Rif-Berber lexis

From the distance matrices, numerical comparative analyses of Berber lexis can be accomplished through two techniques: *Cluster Analysis* and *Multidimensional scaling*. The technique of Cluster Analysis (CA) consists of regrouping data by reducing the distance matrix by means of various algorithms. According to Kleiweg (RuG/L04), I have implemented the Ward algorithm (minimum variance), which is generally regarded as one of the most appropriate algorithms for this type of analysis. On the other hand, multidimensional scaling (MDS) is:

> ... a technique that, using a table of differences, tries to position a set of elements into some space, such that the relative distances in that space between all elements corresponds as close as possible to those in the table of differences. (Kleiweg, RuG/L04)

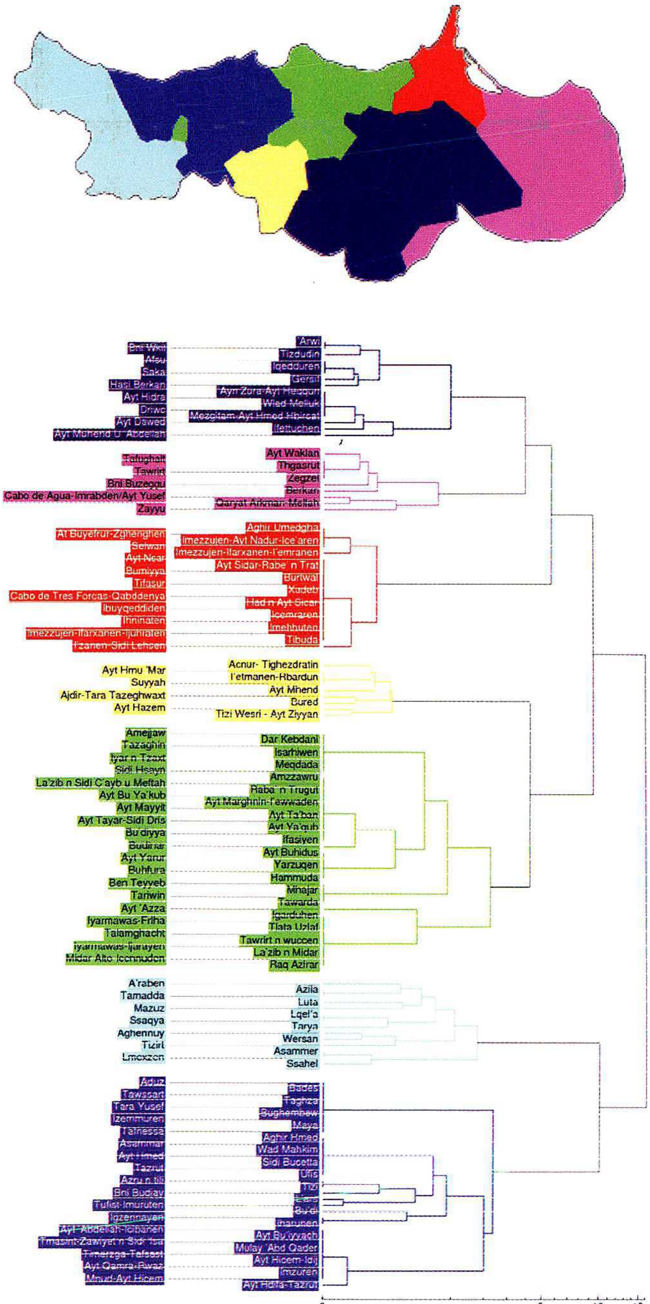
2.5. Visualisation of dialectometry analyses of Rif-Berber lexis

Classification by clustering (CA) necessarily uses a dendrogram for its display. A dendrogram is a complex ranking structure, usually in colour, whose branches represent the linguistic varieties. It can be matched with a digital map, resulting in a geolinguistic map that shows the distribution of linguistic varieties depending on the linguistic differences and the selected classification criteria. In contrast, analyses by Multidimensional Scaling (MDS) directly offer maps on which the relative linguistic variation is gradually represented by different colours.

2.5.1. Visualisation and interpretation of the CA analyses

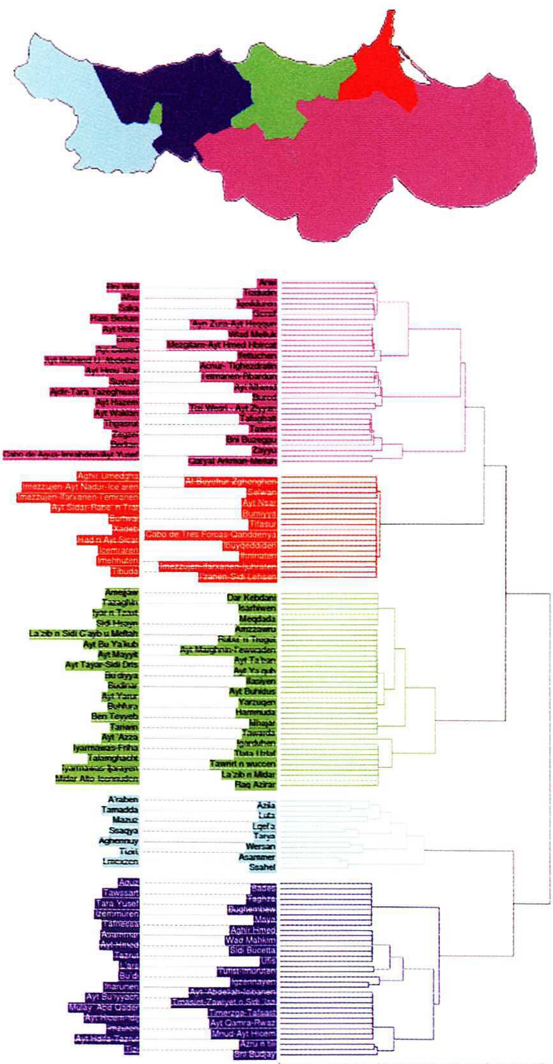
The hierarchical structure of the dendrogram and the corresponding varieties' distribution on the Rif map vary significantly depending on the distance algorithm (Bin, GIW or Lv) applied. Thus, the outcome of the Binary distance comparison (Figure 2) is a configuration consisting of seven main groups, clustered into two subgroups: the minor subgroup containing groups 6 and 7 and the major subgroup containing groups 1 to 5; the distance between these two subgroups is 16.17. This distance value indicates a relatively high linguistic boundary after group 7, which is delimited on the right by the varieties of Ayt Weryaghel and Ayt 'Ammart. The major subgroup shows a rather balanced subdivision (d = 9.34) between groups 4 and 5 (variety of Targist included) and groups 1 to 3, which have also been subdivided. The second important linguistic border therefore coincides with the bordering varieties of groups 4 (Igzennayen) and 5 (Ayt S'id and Ayt Tuzin).

Figure 2: Dendrogram vs. CA Map – Bin – All lexis



The classification based on the GIW algorithm diverges considerably from that based on the Bin algorithm, because it leads to a set of five clusters (Figure 3), of which cluster 1 includes the sub-clusters 1, 2 and 4 of the Bin classification (Figure 2). However, the main linguistic boundary detected through GIW – boundary drawn after the varieties of cluster 5 – is identical to the one that emerged from the Bin dendrogram. Although, the distance between the two major sub-clusters is lower for GIW (d_{GIW} = 10.87) than for Bin (d_{Bin} = 16.17). This difference can be explained by the integration of the frequency parameter in the comparison.

Figure 3: Dendrogram vs. CA Map – GIW – All lexis



The lexis classification obtained through Lv distance corresponds with an asymmetrical configuration of 7 clusters which are structured into 2 major clusters distanced from one another by 8.08 (Figure 4). The matching dendrogram shares the same linguistic main delimitation (between groups 6 and 3-4) with the other dendrograms. This observation is corroborated by the CA_{Lv} maps displayed in Figure 5, of which the 2-cluster map clearly indicates the most distinctive linguistic boundary. It is important to note that the CA_{Lv} map (Figure 4) shows a distribution of the varieties similar to the CA_{Bin} distribution, even though the composition of their respective dendrogram is divergent.

Figure 4: Dendrogram vs. CA Map – Lv – All lexis

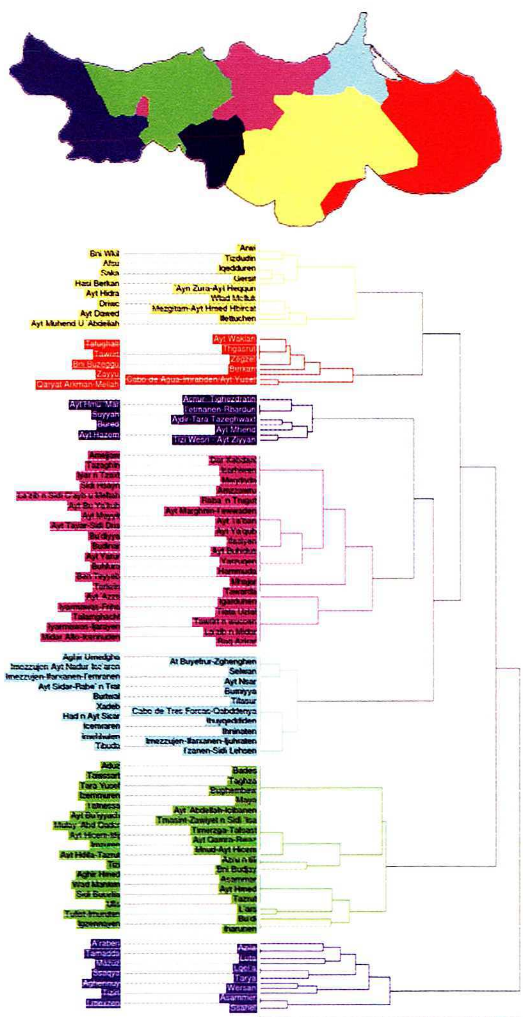
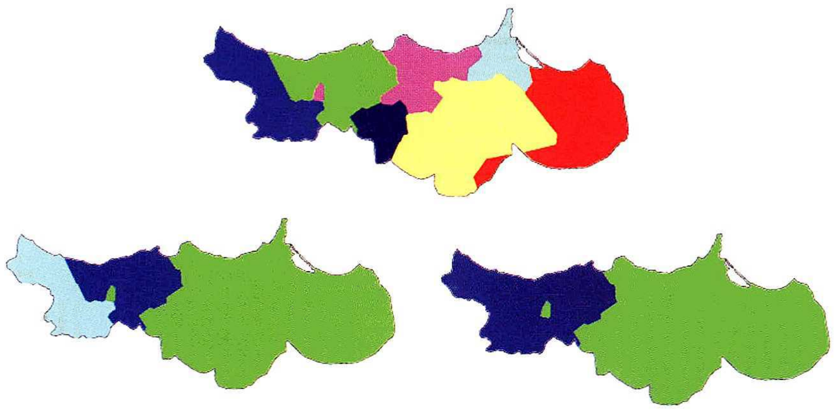


Figure 5: CA_{Lv} maps – 7 clusters vs. 3 clusters vs. 2 clusters – All lexis

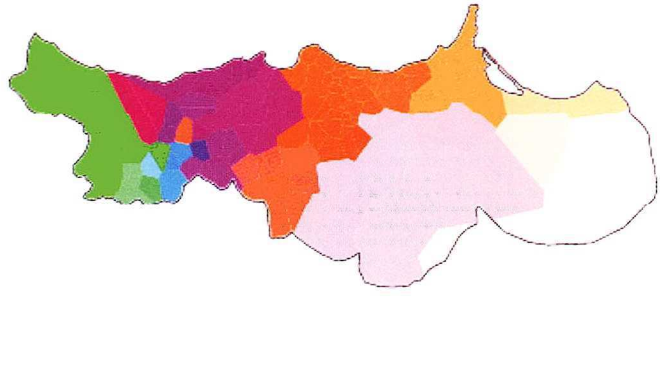


2.5.2. Visualisation and interpretation of the MDS analyses

The MDS technique has the major advantage of ensuring objectivity and accuracy during the analysis stage of the materials because it excludes any external parametering. For example, the number of clusters cannot be changed because the analysis system provides it automatically. Each variety has its own colour. The colour contrasts are used to interpret the compared linguistic data: a colour continuity points to a perfect correlation between lexemes, while a colour mosaic reveals a low correlation between them.

The Rif region is divided into 7 major areas, regardless of the distance measuring applied (Figure 6). The distribution of the varieties on the MDS maps is almost similar to Bin and GIW; only a few minor differences in shades of certain colours were observed. The MDS_{Lv} map closely resembles the other two; the only significant distinction observed is the emergence of a small subdivision inside the group of Western varieties.

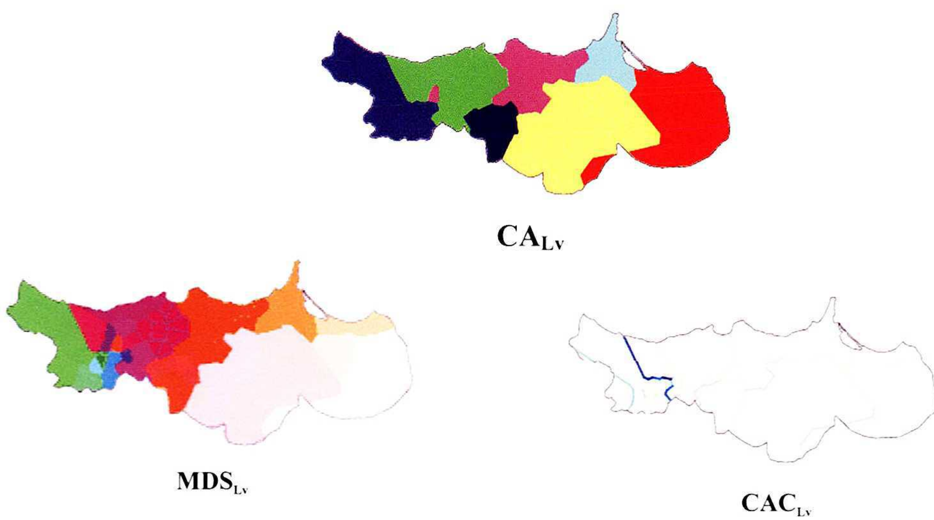
Figure 6: MDS_{Lv} map – All lexis



3. Contrastive results

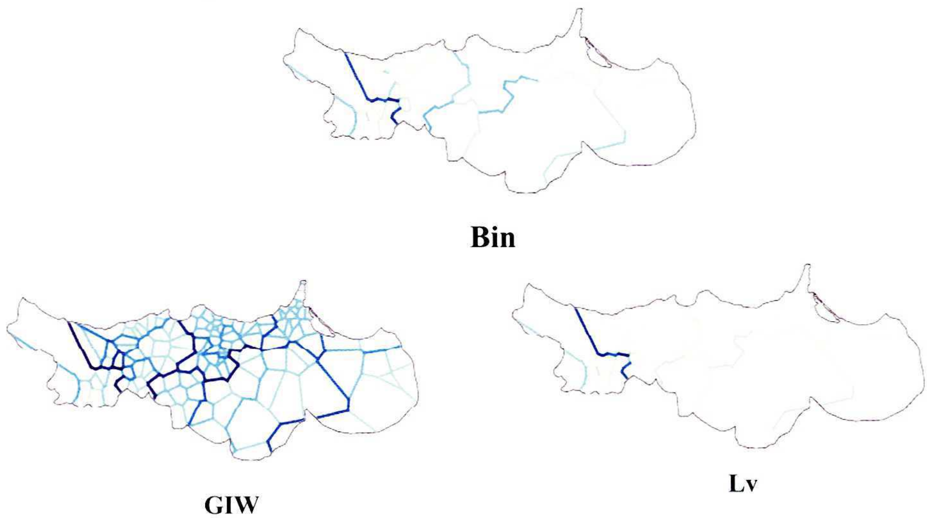
Because of its accuracy, the MDS method is most appropriate for dialectometry analysis of Berber lexis. Accordingly, it forms a yardstick against which other dialectometry methods can be contrasted. Among the Cluster Analyses classifications (CA), CA_{Bin} and CA_{Lv} join best the distribution maps displayed by MDS (7 groups). Moreover, the CA_{Lv} classification shows a further refinement because it takes into account the phonic variation of the units as much as their arrangement in the lexemes. However, any analysis based on Lv distance (CA as well as MDS) ignores the existence of the hierarchy between the phonic units (phonetic units= phonemic units), unless various weights are granted to them through a specific parametring. This method implies the construction of a phonological system within the software, involving a time and energy-consuming effort that is much too expensive compared to its profits.

Figure 7: CA_{Lv} vs. MDS_{Lv} vs. CAC_{Lv} maps



The Cluster Analysis classification has the benefit of precisely indicating significant linguistic boundaries. The CAC maps (Composite Cluster map; Figures 7 and 8) designate these boundaries by dark lines. Compared to the distinctive boundaries drawn by the dendrograms and CA maps of Figures 2 to 5, the principal linguistic delimitation of the CAC map of Figure 7 is drawn further to the West. It is important, nevertheless, to note that the CAC maps do not seem suitable to display the classification of Rif-Berber lexis because of the difficulty of interpreting the data, due to their rather chaotic representation (Figure 8).[8]

Figure 8: CAC – Bin vs. GIW vs. Lv maps – All lexis



References

Chambers J. K.; Trudgill, P. 1998. Dialectology. Cambridge: Cambridge University Press [2nd edition].

Daan, J.; D.P. Blok. 1969. Van Randstad tot Landrand; toelichting bij de kaart: Dialecten en Naamkunde, volume XXXVII of Bijdragen en mededelingen der Dialectencommissie van de Koninklijke Nederlandse Akademie van Wetenschappen te Amsterdam. Amsterdam: Noord-Hollandsche Uitgevers Maatschappij.

Forquet, J. 1956. Linguistique structurale et dialectologie. Festgabe Frings 190-203.

Garde, P. 1961. Réflexions sur les différences phonétiques entre les langues slaves. Word XVII. 34-62.

Goebl, H. 1982. Dialektometrie. Prinzipien und Methoden des Einsatzes der numerischen Taxonomie im Bereich der Dialektgeographie, Philosophisch-Historische Klasse Denkschriften, volume 157. Vienna: Verlag der Osterreichischen Akademie der Wissenschaften.

[8] Kleiweg (RuG/L04) offers some alternatives to the Ward algorithm which seems to be causing visual disorder by which CA_{GIW} maps are mostly affected.

Goebl, H. 1993. Probleme und Methoden der Dialektometrie: Geolinguistik in globaler Perspektive. In: W. Viereck (ed.) Proceedings of the International Congress of Dialectologists. Vol. 1. 37-81. Stuttgart: Franz Steiner Verlag.
Goossens, J. 1965. Die niederländische Strukturgeographie und die "Reeks Nederlandse Dialectatlassen", Bijdragen en mededelingen der Dialectencommissie van de Koninklijke Nederlandse Akademie van Wetenschappen te Amsterdam, volume XXIX. Amsterdam: N.V. Noord-Hollandsche Uitgevers Maatschappij.
Goossens, J. 1969. Strukturelle Sprachgeographie. Eine Einführung in Methodik und Ergebnisse. Heidelberg.
Grosse, R. 1960. Strukturalismus und Dialektgeographie. Biuletyn Fonograficzny III. 89-101.
Heeringa, W. 2004. Measuring Dialect Pronunciation Differences using Levenshtein Distance. PhD. Dissertation. Groningen: Rijksuniverstiteit Groningen.
Hoppenbrouwers, C.; G. Hoppenbrouwers. 1988. De feature frequentie-methode en de classificatie van Nederlandse dialecten. TABU. Bulletin voor taalwetenschap 18(2). 51-92.
Hoppenbrouwers, C.; G. Hoppenbrouwers. 2001. De indeling van de Nederlandse streektalen : Dialecten van 156 steden en dorpen geklasseerd volgens de FFM (feature frequentie methode). Assen: Koninklijke Van Gorcum.
Kessler, B. 1995. Computational dialectology in Irish Gaelic. In: Proceedings of the 7th Conference of the European Chapter of the Association for Computational Linguistics. 60-67. Dublin: EACL.
Kruskal, J. 1999. An overview of sequence comparison. In : D. Sankoff, J. Kruskal (eds.) *Time Warps, String Edits, and Macromolecules: The Theory and Practice of Sequence Comparison*, MA, Addison-Wesley, 1-44.
Lafkioui, M. 2007. Atlas linguistique des variétés berbères du Rif. Köln: Rüdiger Köppe Verlag [in Berber Studies, volume 16), 2007, 291 pp. (format « A3 », in color, 356 maps + 47 tables].
Lafkioui, M. [forthcoming 1]. Etudes de géographie linguistique berbère : variation géolinguistique et classification dialectométrique. Le Bulletin des Séances de l'Académie des Sciences d'Outre-Mer, 22 pp.
Lafkioui, M. [forthcoming 2]. Analyses dialectométriques du lexique berbère du Rif. Studien zur Berberologie/Etudes Berbères 4, 19 pp.
Martinet, A. 1972. Structural dialectology. Pakha Sanjam, N° Spécial.
Moulton, W. G. 1960. The short vowel systems of northern Switzerland. Word 16. 155-182.
Nerbonne, J.; W. Heeringa. 1998. Computationale vergelijking en classificatie van dialecten. Taal en Tongval. 50(2). 164-193.
Nerbonne, J.; W. Heeringa. 2001. Computational Comparison and Classification of Dialects. Dialectologia et Geolinguistica 9. 69-83.
Rensink, W.G. 1955. Dialectindeling naar opgaven van medewerkers. Mededelingen der Centrale Commissie voor Onderzoek van het NederlandseVolkseigen 7. 20-23.
Séguy, J. 1973. La dialectométrie dans l'Atlas linguistique de la Gascogne. Revue de linguistique romane 37. 1-24.

Stankiewicz, E. 1957. On discreteness and Continuity in Structural dialectology. Word. 13. 44-59.
Weijnen, A. 1946. De grenzen tussen de oost-noord-Brabantse dialecten onderling. In: Oost-Noordbrabantsche dialectproblemen: lezingen gehouden voor de dialectencommissie der Koninklijke Nederlandsche Akademie van Wetenschappen op 12 april 1944. Bijdragen en meededelingen der Dialectencommissie van de Koninklijke Nederlandse Akademie van Wetenschappen te Amsterdam. Volume VIII, 1-15. Amsterdam: Noord-Hollandsche Uitgevers Maatschappij.
Weijnen, A. 1966. Nederlandse dialectkunde. Studia Theodisca. Assen: Van Gorcum.
Weinreich, U. 1954. Is a structural dialectology possible? Word 10. 388-400.
Winkler, J. 1874. Algemeen Nederduitsch en Friesch Dialecticon.'s-Gravenhage: Martinus Nijhoff.